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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ekapot Bhunachet, M.D., PhD

Applicant No. 09/936,872

Title: "FLUORESCENCE ELECTRONIC ENDOSCOPIC SYSTEM"

U.S. Filing Date: September 17, 2001

Reply to the final action filed on June 14, 2007,
and interview summary on August 10, 2007Michael Rozanski
Examiner
Art Unit 3768

Dear Mr Rozanski,

As suggested by examiners, an affidavit that substantially and accurately demonstrates that the results of my invention were not predictable has been submitted.

As mentioned in the affidavit, optical fiber-scopes have typically been used for fluorescence observation, though they provide poor images of inferior quality compared with those of electronic endoscopes (or video-endoscopes) (Reference 14, page 886). It is believed that a conventional miniaturized CCD can hardly detect fluorescence lights, which are extremely weak especially in the case of auto-fluorescence (References 12 and 13). This is because the smaller the CCD, the less sensitive it is to light (Reference 14, page 888). MacAulay et al., themselves, mentioned in US 5,827,190 (Palcic B, MacAulay C, et al.) (col. 2, lines 14-19) that, *Prior art endoscopes have been developed that permit the image sensor to be located at the tip of the endoscope probe, however, in general, this endoscope equipment is intended*

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for collecting reflected light and is not suitable for reliably capturing faint fluorescence images. Therefore it can be seen that nobody, including MacAulay et al., would ever have anticipated that a commonly used electronic endoscopic system using a black and white CCD in combination with a rotary color filter wheel with red, green and blue filters to obtain a white light color image could be turned to an excellent fluorescence electronic endoscopic system, simply by placing a barrier filter in front of the black and white CCD to eliminate excitation light. It should also be noted that the technique of using black and white CCDs in video-endoscopes is older than the technique of using color CCDs in video-endoscopes (Reference 14, page 888) and thus was not seen as a progressive technology from which could be expected superior results.

MacAulay et al'660 mentions methods of superimposing the integrated auto-fluorescence image and the remittance light image. However, there is an understandable reason that their method does not work. The fluorescence endoscopic system, LIFE (Light-Induced Fluorescence Endoscopy) manufactured by Killix Technologies (the Assignee of US 5,590,660 and US 5,827,190), Canada and Olympus Corp., Tokyo, Japan, can only provide a fluorescence image (References 4-7). In the LIFE system, the auto-fluorescence is divided into green and red channels, instead of being integrated (Reference 4, page 236).

It can reasonably be assumed that Killix Technologies had tried to integrate auto-fluorescence to one channel as described in MacAulay et al'660, but failed. The reason for this failure was probably the use of color CCDs. For example, in the forth embodiment of MacAulay et al'660 (col. 9, lines 53 to col. 10, line 10), a color CCD is placed at the tip of an endoscope with a barrier filter to exclude the blue excitation light and permit passage of green and longer wavelengths. Since the image sensing means is a color CCD, the auto-fluorescence, composed mainly of green light but also red light (Fig. 1a-d, MacAulay et al'660), will be sensed by both green and red channels.

In my invention where a black and white CCD is used, the fluorescence passing through the barrier filter is, as total, sensed and converted to an

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for collecting reflected light and is not suitable for reliably capturing faint fluorescence images". Therefore it can be seen that nobody, including MacAulay et al., would ever have anticipated that a commonly used electronic endoscopic system using a black and white CCD in combination with a rotary color filter wheel with red, green and blue filters to obtain a white light color image could be turned to an excellent fluorescence electronic endoscopic system, simply by placing a barrier filter in front of the black and white CCD to eliminate excitation light. It should also be noted that the technique of using black and white CCDs in video-endoscopes is older than the technique of using color CCDs in video-endoscopes (Reference 14, page 888) and thus was not seen as a progressive technology from which could be expected superior results.

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It can reasonably be assumed that Xillix Technologies had tried to integrate auto-fluorescence to one channel as described in MacAulay et al'660, but failed.) The reason for this failure was probably the use of color CCDs. For example, in the forth embodiment of MacAulay et al'660 (col. 9, lines 53 to col. 10, line 10), a color CCD is placed at the tip of an endoscope with a barrier filter to exclude the blue excitation light and permit passage of green and longer wavelengths. Since the image sensing means is a color CCD, the auto-fluorescence, composed mainly of green light but also red light (Fig. 1a-d, MacAulay et al'660), will be sensed by both green and red channels.

In my invention where a black and white CCD is used, the fluorescence passing through the barrier filter is, as total, sensed and converted to an

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electric signal simply using the blue channel (unless pseudo-color technique is used). Using a black and white CCD with a barrier filter also provides another advantage over using a color CCD with a barrier filter: remittance green and red lights, which are the same colors as the fluorescence, can be used to pick up the background images with the green and red channels, and these can be superimposed with the fluorescence image sensed by the blue channel. As a result, the image obtained is composed of three colors.

By contrast, if a color CCD is used with a barrier filter, the blue remittance light cannot be used since the barrier filter eliminates all blue light. The green remittance light cannot be used either, because it will be sensed by the same green channel as the majority of auto-fluorescence. Also, it will be impossible to distinguish the fluorescence image from the background image. Therefore, using a color CCD with the barrier filter can provide images made up of only two colors.

MacAulay et al'660 mention the use of three different channels (col.8, lines 21-35) in an additional modification of the apparatus of their third embodiment. Though it has never proven successful, this apparatus can only function when using two cameras attached at the end of a fiberscope, together with a set of dichroic mirrors and filters. This technique should be considered as different from my invention, which functions with a black and white CCD placed at the tip of an electronic endoscope with a barrier filter.

As described in detail in the affidavit, examining the evolution of various systems in the field of fluorescence endoscopy, it is evident that my invention provides results, which had not, and indeed could not, have been anticipated by the endoscopic research community. The techniques used in combination with my invention, i.e. as described in claims 35-40, are therefore not obvious but rather represent simple but profound innovations in the field of endoscopy.

In view of the above, claims 35-40 in this application, together with claim 34, which is now allowed, are believed to be in immediate condition of allowance. Accordingly, the examiner is respectfully requested to pass this application to issue.

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If, for any reason, the examiner finds the application other than in condition for allowance, the applicant requests that the examiner contact Mr. Paul Sadler, a friend who is acting as the interpreter and translator for the Applicant, at his contact number (011-81-29-851-8088) or by e-mail at pauleadler@teukubagrace.org to discuss any steps necessary to place the application in condition for allowance.

If there are any fees required in relation to this communication, please inform the applicant at the fax/phone number 011-81-29-851-8721.

Respectfully submitted,

Date: September 13, 2007

By: Ekapot Bhunachet
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CERTIFICATION OF MAILING

I hereby certify that this correspondence, together with an affidavit, are being deposited with EMS mail in an envelope addressed to Examiner Michael Rozanski, Art Unit 3768, UNITED STATES PATENT AND TRADEMARK OFFICE, P.O. Box 1450, Alexandria, VA. 22318-1450, on September 13, 2007.

Name of applicant:

Ekapot Bhunachet

Date of Sig.: September 13, 2007

Signature: Ekapot Bhunachet

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